B6.

a) The following character encoding is used in a data link protocol:

<table>
<thead>
<tr>
<th>Character</th>
<th>Encoding</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>01000111</td>
</tr>
<tr>
<td>B</td>
<td>11100011</td>
</tr>
<tr>
<td>FLAG</td>
<td>01111110</td>
</tr>
<tr>
<td>ESC</td>
<td>11100000</td>
</tr>
</tbody>
</table>

When using the following four-character frame:

A B ESC FLAG.

Show the bit sequence transmitted (in binary) for the four-character frame for each of these framing methods;

i) Byte count

ii) Flag bytes with byte stuffing.

(8 marks)

b) For this data link protocol, what is the maximum overhead in a byte-stuffing algorithm?

(3 marks)

c) Sixteen-bit messages are transmitted using a Hamming code.

i) How many check bits are needed to ensure that the receiver can detect and correct single-bit errors?

(2 marks)

ii) Show the bit pattern transmitted for the message 1101 0011 0011 0101. Assume that even parity is used in the Hamming code.

(8 marks)

d) What are the TWO main causes of error for digital transmission systems? Illustrate your answer.

(4 marks)

End of Examination
Section A

A1. a) Explain what the unique characteristics of the data link layer are in comparison with the other layers of the OSI model? (8 marks)

b) Ethernet switches operate at the data link layer.
   i) What are the TWO main forwarding methods used on switches? (4 marks)
   ii) Explain how each method operates with the use of supporting diagrams and frame structures. (10 marks)

c) Explain how Layer 2 technologies are only "locally significant" when the boundary ends at the local default gateway. (3 marks)

A2. a) TCP is a transport layer protocol used for many well-known Internet applications. It uses a number of flags in its operation between client and server. Name SEVEN flags and how each is used in client server communication. (21 marks)

b) Explain and justify whether TCP or UDP should be used as the transport layer of choice for reliable communication for Internet applications. (4 marks)

A3. a) What polynomial corresponds to the following bit strings?
   i) 0110010011010110
   ii) 1100110011001101
   iii) 0101010101010111
   (9 marks)

b) The reference polynomial used in a CRC scheme is:
   \[ x^4 + x^2 + 1. \]

A data sequence 1010101010 is to be sent. Determine the actual bit string that is transmitted. (16 marks)

Section B

B4. Internet Email is an asynchronous communication medium based on sent and received text and other multimedia attachments.

a) What are the THREE main components of an end-to-end email system? (6 marks)

b) What THREE protocols can typically be used to access stored user emails on a server component from a client computer? (6 marks)

c) What are the typical limitations of the email protocols used in both the sending and receiving of email messages? (3 marks)

d) With supporting diagrams, explain how an email can be sent from a typical client system and be routed through several different servers and received by an end client. (10 marks)

B5. a) Outline the key differences between packet switching and circuit switching networks? (8 marks)

b) Why does a technology such as ATM choose the use of cells over the use of packets? (8 marks)

c) What parameters does ATM use to achieve Quality of Service? (9 marks)

[Turn Over]